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TRACHEOBRONCHIAL TOILET

BY

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TOO often in the past it has been assumed that the functions of an anæsthetist began and ended in the operating room. There are, nevertheless, several ways in which his special training can be of use in facilitating diagnosis or in treating post-operative complications, and it is to be hoped that in the future he may be given more opportunity to be of service to patients. The practice which is known as "Tracheobronchial Toilet" in the Wisconsin General Hospital is the result of applying the anæsthetist's acquired facility in intubating the trachea to the treatment of respiratory complications. These need not of necessity be the *sequelæ* of an operation or an anæsthetic; they are often encountered in the course of a purely medical condition, and are sometimes seen as the result of an overdose of drugs which depress respiration. Sometimes intubation is performed primarily for the relief of respiratory obstruction caused by solid substances; to provide a patent airway. Such cases are not considered in this paper, for the term

"Tracheobronchial Toilet" is only used to describe the procedure where intubation enables foreign matter to be removed from the respiratory tree by suction.

The ability to remove secretions from the respiratory tract has been recognized as valuable for many years. In 1912 Franz Kühn[1] described such a use of his wide-bore tracheal tube made of flexible metal coils. More recently Jackson,[2] Negus,[3] Mousel,[4] Eversole,[5] and many other workers have advocated the removal of secretions by bronchoscopy. We therefore can claim no originality in applying a new name to a practice of established value. The purpose of this paper is to draw attention to its utility, to describe the methods which have been successful in our hands, and to state the results which we have obtained.

Indications

Tracheobronchial toilet is indicated in two different varieties of cases, and for different reasons.

First: in patients who are debilitated as the result of a severe operation, by reason of their general condition, or whose respiration has been depressed by the administration of certain drugs. If such a patient has excessive secretions, or if he inadvertently inhales foreign substances, he often lacks the ability to cough them out and must therefore suffer the effects of the partial respiratory obstruction to which their presence gives rise. Moreover the cough reflex is usually sluggish in these patients and the activity of their ciliated epithelium may have been decreased by the use of opiates; a fact recently demonstrated by Curreri and Hibma.[6] Elderly patients often show an impairment in the activity of the cough reflex, as do persons suffering from lesions of the brain. They are therefore prone to aspirate fluid foods or vomitus into the respiratory tract, and, if these are not removed, to develop bronchopneumonia. Nosworthy[7] has drawn attention to the importance of removing secretions in the debilitated patient.

Second: in any patient suffering from atelectasis. This category is comprised of patients who are usually in better physical condition than those just described, although they

are often temporarily depressed as the result of recent surgical intervention or of the administration of sedative drugs. Atelectasis is probably due to the obstruction of a bronchus or bronchiole by secretion or to compression resulting from abnormal positions or tight dressings. Oxygen and the anæsthetic gases have been shown to be rapidly absorbed from the alveoli[8, 9] and if they comprise the alveolar atmosphere at the time—as is usually the case during anæsthesia—the ensuing collapse will be rapid. If the occluding substance can be removed as soon as the diagnosis is made, the collapsed area of the lung will re-expand. If the diagnosis is missed, infection soon sets in and bronchopneumonia results. Bronchoscopic drainage is the recognized treatment for atelectasis.[3, 4] It is, however, a proceeding which demands the services of a person of special training and skill which the majority of anæsthetists do not possess, and for this reason it is likely to lead to trauma if practised by them. A skilled bronchoscopist is not always available at a moment's notice. On the other hand an anæsthetist should be available at any time, and in these days is experienced in the introduction of a wide-bore rubber tube into the trachea. In his hands this proceeding is certainly safer than is bronchoscopy.

Our experience with tracheobronchial toilet has led us to the belief that it succeeds sufficiently often in clearing an occluded bronchiole that it should almost always be performed as treatment as soon as the diagnosis is made. Should it fail, a resort to bronchoscopy is justifiable. Either method may cause the patient to cough violently, a circumstance which, in certain cases, may prove the most important part of the treatment.[10]

Technique

It may be necessary to perform tracheobronchial toilet upon the conscious patient in bed. It is of the utmost importance to secure the co-operation of the patient, and therefore the steps to be taken and the necessity for them should be explained to him beforehand and his assistance enlisted. The sudden inability to speak occasioned by intubation

frightens some individuals, and a pencil and paper should be at hand so that communication between patient and anæsthetist is possible. The mouth, nose, fauces, and pharynx are then carefully anæsthetized. They may be sprayed with a nebulizer containing any one of the solutions commonly used to produce analgesia of mucous surfaces. We usually use either a 4 per cent solution of cocaine or a 1 per cent solution of "Diothane." Since the better the analgesia the more easily may intubation be accomplished, the anæsthetist should be at some pains to spray thoroughly all the structures involved. He should then allow the necessary time for the solution to take effect. Analgesia of the pharynx can be induced more easily if the patient first allows a troche of "Decicain" or a similar tablet to dissolve on his tongue as he lies in the supine position.

When efficient analgesia has been secured intubation is performed. Either route has its advantages and drawbacks. Blind nasal intubation by the method of Magill,[11] when used by an experienced worker, succeeds in the majority of cases but is more difficult to perform than in most anæsthetized patients. If the patient will pant voluntarily at the right moment, he can facilitate intubation. Such an intubation may be less distressing to the patient than one which involves laryngoscopy, but nasal tubes sometimes become kinked in their course[12] and in such a case will not admit of the passage of the suction catheter. Oral intubation demands laryngoscopy because tactile intubation is not only uncertain but is probably even more unpleasant to the patient. When laryngoscopy is undertaken in the conscious patient, the anæsthetist must be very gentle in all that he does. If he is, and if he can win the patient's confidence and so his co-operation, the actual intubation presents little difficulty unless the subject has a short and thick neck. Although it may seem drastic and inhuman to subject a conscious patient to intubation, several of them have volunteered the statement that the relief which they experienced was worth the discomfort involved. In this series of ninety-three cases, intubation failed on six occasions. In the remaining eighty-seven cases, the oral route was used sixty-six and the nasal twenty-one times. A sharp bout of coughing

usually accompanies the passage of the tube into the trachea. Its intensity can be minimized by the use of an analgesic paste, such as that recommended by Brennan,[13] to lubricate the tube. The irritation can also be somewhat allayed by directing the spray from the nebulizer into the tube during inspiration. When oral intubation is performed, some form of prop or "bite-block" should be placed between the teeth before the laryngoscope is withdrawn so that the patient cannot bite the tube.

A special suction tube, of a consistency similar to that of an ureteric catheter though of larger gauge, is desirable. The tendency of the tip of such a tube to curve slightly may be exploited to induce it to pass into the right or left bronchus at will. A rubber urethral catheter, thirty centimetres long and from size 14–18 of the French gauge, may serve the purpose. A number of additional holes should have been pierced in the terminal one inch by passing a red-hot pin or knitting needle through it. The suction catheter is then lubricated well and connected to the source of suction. It is passed to its full length through the endotracheal tube. The patient usually coughs violently as the end of the catheter emerges from the endotracheal tube and passes down to the bifurcation and into a bronchus. An effort should be made to cause the catheter to enter both bronchi in turn by rotation of the suction tube and by an alteration in posture of the patient. When no further secretions can be aspirated, both catheter and endotracheal tube are withdrawn.

Figure 1 shows the position of the endotracheal tube and that of the suction catheter. It is an antero-posterior radiograph of the neck and chest of a patient in whom tracheobronchial toilet was being performed at the close of a gastric operation. Intubation had been performed orally with a flexible metal tube, and an opaque catheter was used for aspiration. An opaque gastric tube was in position in the stomach during the operation. The disconnected end of the endotracheal tube, and the fingers passing in the opaque suction catheter can just be seen in the upper part of the radiograph.

Anæsthetists experienced in endotracheal insufflation as

defined by Meltzer and Auer[14] do not need to be reminded of the dangers inherent in obstruction to the free exit of the insufflated gases. If this occurs, the insufflation pressure is brought to bear upon the bronchial tree and rupture of the alveoli and emphysema can result.[15] Conversely, it is equally dangerous to apply suction to a single tube passed into the trachea. If the cords should close around the tube or any other obstruction to the free entry of air from without should occur, the negative pressure exerted by the suction will be applied to the lower respiratory tract. This is likely to cause massive collapse of both lungs. Thus it is only safe to apply suction to the bronchial tree when a wider tube—whether endotracheal tube or bronchoscope—is already in place between the cords.

Discussion

We cannot emphasize too strongly the importance of clearing obstructing fluids from the trachea and bronchi at the earliest possible moment. If the patient's disposition and condition are such that he may succeed in expelling the offending material by changing his position and by voluntary coughing, active intervention may be postponed until his own efforts have proved of no avail. In our earlier cases, however, more active measures were too often neglected until the patient was in extremis. This mistake is similar to one made in the past as regards the administration of oxygen. With increasing experience our attitude has tended towards reliance upon early intervention rather than upon watchful waiting. In fact, many patients have been subjected to the procedure as a prophylactic measure at the close of an operation and before extubation with gratifying results. In the course of 1940, twenty-five per cent of all cases anæsthetized by the endotracheal technique were so treated. These cases are not considered in this paper.

In reviewing the records of the cases referred to in Table I, we feel that some at least of the unfortunate outcomes might have been prevented by an earlier application of the treatment. This review of our experience with tracheo-

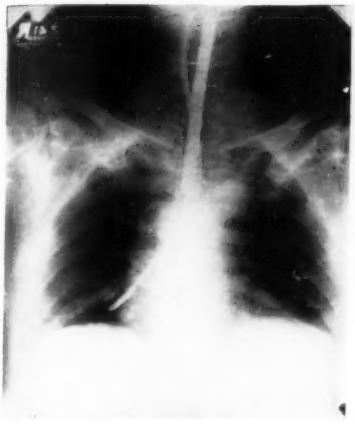


FIG. 1

Antero-posterior radiograph of the chest to show the performance of tracheobronchial toilet. Note the opaque gastric tube in the œsophagus.

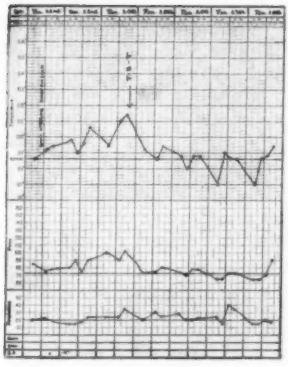


FIG. 2 (*a*)

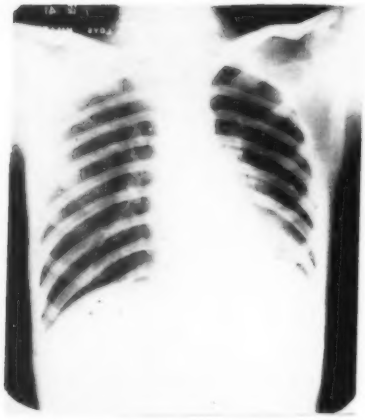
Temperature chart of a patient treated for atelectasis by tracheobronchial toilet.

FIG. 2 (*b*)

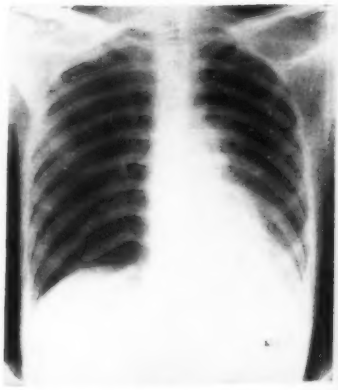
The radiograph of this patient's thorax before tracheobronchial toilet.

FIG. 2 (*c*)

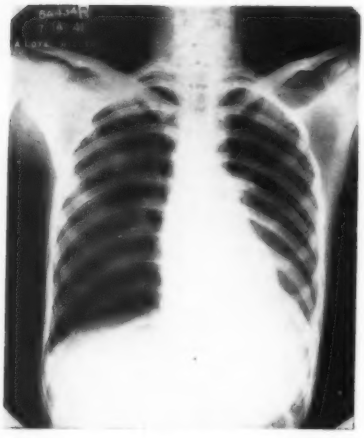
The radiograph of this patient's thorax after tracheobronchial toilet.



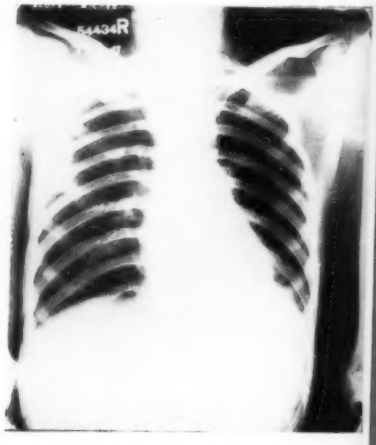
1. July 12th, at the onset of atelectasis.



2. July 13th, after tracheobronchial toilet and before bronchoscopy.



3. July 14th, after bronchoscopy.



4. July 25th, 11 days after bronchoscopy.

FIG. 3

The negative results of tracheobronchial toilet and bronchoscopy in a case of atelectasis in a subject suffering from poliomyelitis.

bronchial toilet at the Wisconsin General Hospital leaves us with the impression that we have erred more often in delaying the procedure than by applying it too hastily. We do not feel that it should replace the hourly insistence on coughing, deep breathing and change of position in depressed patients, referred to elsewhere[16] as the "Ravdin Stir-up." We do believe, however, that a careful tracheobronchial toilet may be performed and repeated to advantage in patients who are having difficulty in clearing their air passages by their own efforts. In cases in which repeated aspiration at short intervals is necessary, it may be advisable to perform tracheotomy to facilitate it.

An early diagnosis of atelectasis is essential. The physical signs are usually difficult to elicit because the patients have undergone an operation and the dressings hinder an efficient examination of the thorax. No reliance should therefore be placed on physical signs. If a patient exhibits a sudden rise in temperature, pulse rate or respiratory rate and is seen to have asymmetrical respiratory movements, he should be treated for atelectasis. Dyspnœa and cyanosis are not always present. If a radiograph of the chest can be rapidly obtained, so much the better. But the treatment should not be delayed for radiography. Figure 2 shows the temperature chart and radiographs of a patient in whom a massive collapse of the right lower lobe occurred on the second day after an operation for suspension of the uterus. The diagnosis was made at once, and tracheobronchial toilet was performed. Its beneficial results are evident from the temperature chart and the radiographs. Twenty-four hours later the condition recurred. On this occasion the patient was able to clear her air passages by her own efforts. She then made an uninterrupted recovery.

Atelectasis and Intercostal Paralysis

In two cases atelectasis occurred in patients suffering from anterior poliomyelitis whose intercostal muscles had undergone marked wasting. In the first of these, blind nasal intubation was performed while the patient was in a mechanical respirator. Aspiration through the tube resulted

in a sudden gush of almost two ounces of pus. The physical signs of atelectasis, however, persisted and were not altered by a bronchoscopic aspiration twenty-four hours after the tracheobronchial toilet. The patient recovered although the collapsed lobe never re-expanded and eventually became fibrotic.

Figure 3 shows the radiographs of the second of these cases. The collapse occurred on July 12th, and tracheobronchial toilet was performed that night. The next morning the patient's general condition was improved but the physical signs had not altered. A second radiograph was then obtained and bronchoscopy was resorted to. The third radiograph shows that this was no more effective than the original treatment in promoting re-expansion of the lobe. Nor did the physical signs alter. The fourth radiograph was taken some time later, and shows early fibrotic changes. The patient recovered nevertheless and has been discharged from the hospital.

Results

In the four years and eight months from January 1937 to August 1941, therapeutic intubation has been attempted ninety-three times in this hospital. Intubation failed on six occasions. Of the remaining eighty-seven cases, sixteen were treated primarily for the relief of inadequate gaseous exchange caused either by obstruction or inadequate movement. There remain for consideration seventy-one cases of which the results are shown in Table I.

These results show that tracheobronchial toilet has been more successful in the treatment of atelectasis than in patients who lacked the strength to cough up their own secretions. The reason for this is that the patients suffering from atelectasis were, in the main, in better general condition than the patients in the latter category. Although temporarily suffering from the effects of a recent operation, their powers of resistance were good; whereas all but nine of the patients in the other category were gravely ill, and in the majority of cases actually moribund. Of the patients who were unable to cough up their own secretions we feel that, in spite of the fact that most of them eventually died,

TABLE I*

I—*Cases in which tracheobronchial toilet was performed primarily for the aspiration of secretions.*

II—*Cases in which tracheobronchial toilet was performed primarily for the treatment of atelectasis.*

	No. of cases	Improved Did well	Improved Relapsed	No change Recovered	Improved Relapsed Died	No change Died	Moribund when seen Died
I	30	3 cases 10.0%	4 cases 13.3%	0 0	12 cases 40%	4 cases 13.3%	7 cases 23.3%
II	41	25 cases 60.9%	3 cases 7.3%	3 cases 7.3%	5 cases 12.2%	4 cases 9.8%	1 case 2.4%

* The end-results of 71 cases of tracheobronchial toilet.

many lived longer and some recovered largely because the freedom of their airway was restored by the use of this technique. If tracheobronchial toilet is to be of use, it must be applied as early as possible and not employed as a last resort to a dying patient.

Summary and Conclusions

1. A method of aspirating secretions from the trachea simpler than bronchoscopy and more easily applied by an anæsthetist, is described under the title of tracheobronchial toilet.

2. Its uses and results in the treatment of atelectasis and of patients unable to cough out their own secretions are described. The results have been much better in the former than the latter category for reasons which are explained.

3. The importance of early diagnosis and treatment of these conditions is stressed.

4. Disappointing results have been encountered after both tracheobronchial toilet and bronchoscopic aspiration in patients suffering from paralysis of the intercostal muscles due to poliomyelitis as well as atelectasis.

5. The results of tracheobronchial toilet during a period of four and a half years are shown in tabular form.

We believe that an anæsthetist who is skilled in intubating the trachea can be of great assistance in the treatment of respiratory complications in the post-operative period.

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POST-OPERATIVE PULMONARY COMPLICATIONS IN TROOPS

BY

T. A. B. HARRIS, D.A., MAJOR R.A.M.C.

ANY factor which prolongs the period of stay of troops in hospital is an economic loss to the war effort. Post-operative pulmonary complications must be regarded thus and are of even greater import when they result, through disability or death, in the loss of a trained man to the army.

This series of cases consisted of the normal surgical intake of troops in this training area, together with British, French and Polish casualties from Dunkirk. Their average age was 25.5 years, and during the 23 months under review anæsthesia for the 1851 cases described was administered by the same anæsthetist. Of these, 140 cases developed a post-operative pulmonary complication and the pulmonary morbidity was 7.5 per cent. There were no deaths either during anæsthesia or as a result of pulmonary complications following anæsthesia, and the pulmonary mortality was nil. The routine pre-operative medication employed was scopolamine gr. $\frac{1}{150}$ and alopon gr. $\frac{1}{3}$ and inhalation anæsthesia, which usually consisted of nitrous oxide-oxygen and ether, was used in 92 per cent of cases.

The nature of post-operative pulmonary complications is seen in Table I.

TABLE I.

Mild bronchitis (no temperature)	44
Moderate bronchitis (temperature up to 100°F.) ...	37
Severe bronchitis (temperature over 100°F.)	49
Bronchopneumonia	5
Atelectasis	3
Embolic	2
Total	140

Defence of the Pulmonary System

To attribute the absence of a post-operative pulmonary complication to a single influence such as the pre-operative use of ephredine or the post-operative use of atropine is to ignore the whole mechanism employed by the body for the defence of the pulmonary system.

The pulmonary system is defended against air-borne infection by the presence of a layer of pulmonary secretion which covers the respiratory epithelium and by the movement of this fluid film towards the exterior by the combined effect of ciliary action and the rhythmic peristaltoid movement of the whole respiratory tract.

Pulmonary secretions are the product of glands which are embedded in the deeper layers of the respiratory epithelium and of the goblet cells of the respiratory epithelium. In the trachea these glands are so numerous as to form an almost continuous layer, but diminish progressively in size and number as the calibre of the respiratory passages narrow and are absent in the bronchioles. Goblet cells are not numerous in normal respiratory epithelium. The glands secrete a fluid similar to that of the lacrimal glands, goblet cells secrete almost pure mucus and the combined secretion of the respiratory tract in normal conditions consists of 3 per cent mucin, 2 per cent of solids and 95 per cent of water.

The cilia of the respiratory tract extend as far as the smaller bronchioles, and small particles of bacteria entangled in the film of pulmonary secretion are propelled towards the exterior by ciliary action at a rate equivalent to 40–60 inches per hour.

Ciliary action is assisted by the rhythmic peristaltoid movement of the whole respiratory tract which is produced by the lengthening and dilatation of the bronchial tree on inspiration and its shortening and narrowing during expiration. It therefore promotes bronchial drainage throughout the whole respiratory tract and its efficiency varies in an upward and a downward direction with the depth of breathing.

The fact that the respiratory epithelium of the finer bronchioles and air cells lacks both glands and cilia suggests

that when bronchial drainage is efficient, this part of the pulmonary system, though moist, is mucus-free, and point is given to this supposition and at the same time to the efficiency of normal bronchial drainage, by the fact that even in the presence of naso-pharyngeal infection, alveolar air is invariably sterile.

When this normal mechanism for any reason becomes incapable of promoting efficient bronchial drainage, pulmonary secretions, which may or may not be infected, tend to enter the finer bronchioles and possibly the air cells, and in this event two further means of protecting this part of the pulmonary system are called into action. They are the act of coughing, which is a temporary expedient to deal with a state of emergency, and the lobular collateral air circulation.

A cough consists of an inspiration followed by an explosive expiratory act which necessitates the active co-operation of the larynx and all the muscles of expiration. Since the residual air is a fixed volume which cannot be expelled by any muscular effort, the volume of air expelled by the violent expiratory act of coughing depends upon the volume of air drawn into the lungs by the previous inspiratory phase. Since, moreover, the amplitude of peristaltoid movement depends upon the depth of breathing, it follows that not only the volume of the "battering ram" of air expelled but also the degree of shortening and narrowing of the whole bronchial tree, the effectiveness of the cough in fact, depends upon the depth of inspiration which precedes the violent expiratory effort.

The effect of a cough is generally held to be confined to the upper air passages, but it is clear that it exerts a powerful effect throughout the whole respiratory tract.

Van Allen, *et al.*,[1] have shown without doubt the presence of a lobular collateral air circulation. They have demonstrated that when the permeability of the interlobular septa is normal, an obstructed lobule can be efficiently aerated by diffusion through this septa from adjacent unobstructed lobules. This mechanism allows the act of coughing effectively to reach the air cells of the obstructed lobule, for the increased intra-pulmonary pressure generated by an effec-

tive cough hastens diffusion from the unobstructed to the obstructed lobule and, moreover, builds up in the obstructed lobule a higher pressure of alveolar air, so that with the next violent expiratory act of coughing, an accumulated bronchiolar plug of secretion is more readily dislodged.

The successful defence of the pulmonary system against air-borne infection therefore depends upon a film of pulmonary secretion whose volume and viscosity is such that the two complementary processes, ciliary action and rhythmic peristaltoid movement, provide efficient bronchial drainage. When this mechanism becomes an inefficient means of keeping the finer bronchioles and air cells mucus-free, to the risk of infection must be added the additional risk of atelectasis; and an effective cough combined with efficient lobular collateral air circulation is necessary if these risks are to be avoided. For example, in a minor respiratory infection in an otherwise healthy subject, there is little doubt that during sleep pulmonary secretions accumulate in the finer bronchioles and that collapse is prevented by the efficient lobular collateral air circulation and the accumulated secretions removed immediately on awaking by the combined result of efficient lobular collateral air circulation and an effective cough.

This mechanism is the background against which post-operative pulmonary complications must be discussed.

During every surgical procedure, the nature of the anæsthetic preparation and the surgical trauma inflicted, reduces in efficiency or totally abolishes not only the mechanism which protects against air-borne infection but also the mechanism responsible for the spontaneous removal of pulmonary secretions and pulmonary stasis and cardiovascular embarrassment of a certain minimal intensity and duration is inevitably produced. Hence the factors responsible for post-operative pulmonary complications consist of this inevitable factor, hereafter referred to as the basic factor, and a number of occasional factors, the most important of which are those which intensify or prolong the basic factor and those which by increasing the volume of viscosity of pulmonary secretions overtax the mechanism of bronchial drainage.

TABLE II.

Site of operation	Chest complications D. S. King[2] Women	Men	T. A. B. Harris Troops
Stomach and duodenum	17%	47%	35%
Gall bladder	14%	36%	28%
Intestine	13%	26%	24%
Appendix	6%	14%	25%
Hernia	4%	9%	14·5%
Gynæcological	6%	—	—
Miscellaneous	5%	11%	11%
Total abdominal	8%	18%	20%
Total extra-abdominal	0.8%	1.04%	0.7%

Basic Factor

The influence of the basic factor is seen in Table II and the incidence of post-operative pulmonary complications in soldiers and civilians is seen to vary with the intensity of pulmonary stasis as determined by the site and nature of the surgical procedure. Table II also indicates that a given intensity of pulmonary stasis exercises a relatively greater influence in abdominal than in extra-abdominal operations. In extra-abdominal operations there is no post-operative diminution of vital capacity and this implies efficient bronchial drainage in convalescence, for it indicates the ability to breathe deeply and consequently the ability to cough effectively, and the early return of efficient bronchial drainage neutralizes or abolishes the set of circumstances created during surgical interference by the basic factor. In abdominal operations, because of trauma to the abdominal muscles, pain on breathing reduces the vital capacity in convalescence after lower abdominal operations 40–50 per cent, and after upper abdominal operations 65–80 per cent.[3] In abdominal operations, therefore, to the pulmonary stasis produced during surgical interference must be added a period of pulmonary stasis during convalescence. It varies with the site and nature of surgical interference and this delayed return of efficient bronchial drainage prolongs the

set of circumstances created during surgical interference which predispose to post-operative pulmonary complications. The pulmonary stasis and cardiovascular embarrassment inevitably produced by the basic factor therefore varies with the site and nature of the surgical procedure, but its influence is materially reduced by the early return of efficient bronchial drainage.

Table II also shows that the incidence of post-operative pulmonary complications for the total abdominal operations and for the commonest abdominal operations in this series, appendicectomy and herniotomy, is greater in troops than in civilian males, and since troops react to the unavoidable basic factor in the same manner as civilian males, this difference must be attributed to occasional factors which are present in soldiers but absent in civilians.

Occasional Factors

The basic factor may be intensified or prolonged by slow or rough surgery and by the character of the anæsthetic preparation.

TABLE III.

Duration of operation	Chest complications	
	Abdominal operations	Extra-abdominal operations
1 to 29 minutes	5.2%	0.0%
30 to 59 ,, ...	23.0%	1.4%
60 to 89 ,, ...	26.0%	1.0%
90 to 145 ,, ...	40.0%	0.0%

Table III shows that in abdominal operations the incidence of post-operative pulmonary complications in troops increases with each additional half hour of operating time to reach 40 per cent when the duration of surgical interference exceeds 90 minutes. In extra-abdominal operations, however, due to the early return of efficient bronchial drainage, the duration of surgical interference is seen to bear no

relationship to the incidence of post-operative pulmonary complications.

Spinal and local anæsthesia on the trunk produce intense pulmonary stasis of fixed duration, for anæsthesia to be efficient must be absolute, but the flexible control of inhalation anæsthesia permits the intensity and duration of the basic factor to be reduced to the smallest proportions possible for a specific surgical procedure, and the influence of this decrease in the intensity and duration of the basic factor produced by the state of anæsthesia is seen in Table IV.

TABLE IV.
(ABDOMINAL CASES)

	Post-operative pulmonary complications			
	Troops		Civilian	
Anæsthetic	Harris	Tattersall	King	Rivett and Quale
Open ether	—	71%	12.4%	—
Nitrous oxide-oxygen and ether	19%	78%	—	—
Spinal	40%	84%	16.7%	—
Local	—	—	18.4%	—
Continuous intravenous	—	—	—	6%

The volume of pulmonary secretion is increased in pulmonary œdema and the viscosity and volume is increased by asphyxia, local irritation of the respiratory epithelium and pre-operative respiratory infection.

Pulmonary œdema occurs in cardiac decompensation but may be caused by the increased negative intrapleural pressure produced by obstruction to inspiration and the transudate which results is serous in character.

Asphyxia and local irritation result from errors and accidents during anæsthesia. Since the glands of the respiratory epithelium are paralysed during induction by pre-medication and during maintenance by surgical anæsthesia, the abnormal pulmonary secretions which result from asphyxia or local irritation are the product of goblet cells alone and are in consequence almost pure mucus. For example, in

a Boyle-Davis anæsthetic for tonsillectomy, the beads of mucus sometimes seen on the dry, glazed surface of the palate are the product of isolated goblet cells and are attributed to the local irritation of a stream of too concentrated, cold ether vapour.

A clear distinction must be drawn between the effect of cold and warm ether. Sir Francis Shipway found the temperature under an open mask from 4–12°F. lower than when warm ether from a Shipway's apparatus was employed, and Geoffrey Marshall (1923) states that when warm ether from a Shipway was substituted for open ether, the incidence of post-operative pulmonary complications in troops immediately fell from 54 to 14.7 per cent.[4] This striking result has been attributed to the irritating effect of cold ether vapour, but it is probably due to the inhalation of droplets of fluid ether, for the low vapour pressure of cold ether leads to the soaking of the mask with fluid ether in an effort to achieve anæsthesia.

I have measured with a thermo-couple the temperature between the ether bottle and the rebreathing bag of a standard army water flowmeter Boyle apparatus. When the gas flow consisted of nitrous oxide-oxygen the temperature was 2°C. below theatre temperature, nitrous oxide-oxygen flowing over warm ether, 4°C.; flowing over cold ether, 10°C.; and bubbling through cold ether, 16–20°C. below theatre temperature.

In this series of cases, warm ether was always used and when the effect of nitrous oxide-oxygen, which is not cold and is non-irritating, is contrasted with nitrous oxide-oxygen and warm ether, in a comparable series, i.e., in extra-abdominal operations, it is seen that the incidence of post-operative pulmonary complications is as 0.55 per cent to 0.78 per cent.

TABLE V.

(EXTRA-ABDOMINAL OPERATIONS)

Anæsthetic	Number	Chests	Percentage
Nitrous oxide-oxygen	181	1	0.55
Nitrous oxide-oxygen and warm ether	875	7	0.78

Since, moreover, local irritation renders the interlobular septa impermeable to the diffusion of gases, the low incidence of atelectasis in the whole series indicates that local irritation was an insignificant influence.

If, therefore, the water jacket of the standard army Boyle's apparatus is replenished frequently enough to keep the fluid ether warm, the ether vapour supplied is warm and because its vapour pressure is relatively high, anæsthesia is readily maintained without a turbulent flow of gases through the fluid ether and the possibility of droplet contamination of the respiratory passages is avoided.

For one or other of the above reasons, local irritation was not a relevant factor in this series.

The inefficient bronchial drainage which occurs during surgical interference exposes the subject to the risk of pulmonary infection from dental and naso-pharyngeal sources and materially increases the possibility of an exacerbation or the extension of a pre-existing respiratory infection.

The teeth of the troops in this series were uniformly good. Many soldiers had irritated throats due to cigarette smoking, and Table VI shows the result of a survey of the bacterial

TABLE VI.

	Swab				Sputum
	Aerobic		Anærobic		
Organism	Officers %	Men %	Officers %	Men %	Men %
Strep. Virid.	25	42	25	42	32
Staph. Albus.	75	42	75	42	87
Rough Pneum.	50	33	50	35	48
M. Cath.	50	50	50	47	52
Staph. Aureus.	15	12	15	10	—
B. Influenza	5	2	5	—	42
Haem. Strep.	—	18	—	12	—
Pneum. 1.	—	—	—	—	3
Pneum. 3.	—	—	—	—	3
B. Proteus.	—	—	—	—	6

(Personal communication from Capt. R. N. Tattersall)

flora of the naso-pharynx of troops at a military hospital by Captain R. N. Tattersall.[5] A similar examination conducted by Captain A. A. Black in the Command Laboratory at this station, showed the same types present but the percentages were lower than those of Tattersall.

Minor respiratory infection is very prevalent in troops and Figure 1 shows the monthly percentages of naso-pharyngeal and minor respiratory infections in the total cases seen in the medical inspection room of this station during the 23 months under review.

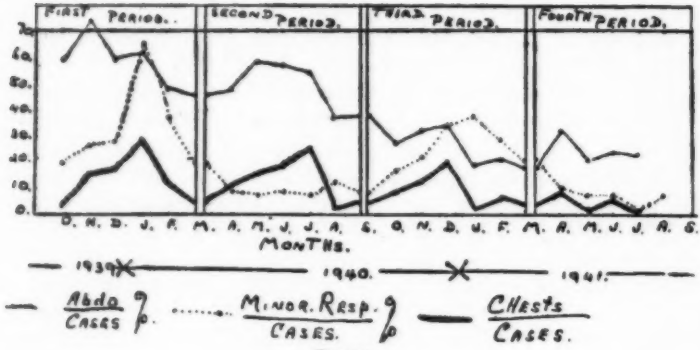

FIGURE 1

The prevalence of naso-pharyngeal and minor respiratory infection in soldiers can be attributed to accommodation and habits of life. The fug produced in huts, barracks and air-raid shelters at night followed by days spent in violent exertion in the open air exposed to the weather, provides a probable provocative cause, and the relatively crowded accommodation—32 men to a hut—provides a set of circumstances suitable for the spread and, at the same time, a reason for the chronic nature of naso-pharyngeal and minor respiratory infections in troops. These factors are also responsible for the seasonal variation, seen in Figure 1, for the longer periods of ill-ventilation and the vagaries of the winter weather contrast with summer conditions.

The character of the surgical intake and the limitations imposed by war-time military surgery determine that the incidence of naso-pharyngeal and minor respiratory infec-

tion in the troop population is a reasonably accurate index of the incidence of pre-operative respiratory infection in the troops operated on. The surgical emergencies of necessity provide an accurate cross-section of the incidence of minor respiratory infection in the troop population, and in this series 37 per cent of cases were surgical emergencies, one half of whom (19 per cent of the whole series) required surgical interference because of violence due to the hazardous nature of the soldiers' occupation. The same may be said of the remaining 63 per cent of cases, the premeditated or interval cases, as in war-time military surgery it is not feasible to postpone surgical interference because of pre-operative respiratory infection, for it is neither possible to retain cases in hospital for periods of pre-operative treatment nor to return them to their units for treatment and it is questionable whether their respiratory infection would benefit by such a course. The graph in Figure 1 can therefore be taken as an accurate index of the incidence of pre-operative respiratory infection in this series.

The character of pre-operative respiratory infection in the troops of this series ranged from bronchitis to "excessive bronchial secretion" during the day and the expectoration of a drachm or so of muco-pus first thing in the morning. Excessive bronchial secretion in otherwise healthy troops was observed in the Great War, and Geoffrey Marshall[4] states, "autopsies on men even when they have had no anæsthetic, commonly show the lung tissue to be congested and an excessive secretion in the tubes." The condition described by Marshall was observed in the lungs of two such soldiers examined early in 1940.

Table VII shows the influence of pre-operative respiratory infection upon the incidence of post-operative pulmonary complications during the first quarter of 1941 when the chest of each case was examined immediately prior to surgical interference, and it is clear that when pre-operative respiratory infection is added to the basic factor, it exerts a dominant influence in the production of a post-operative pulmonary complication but the early return of efficient bronchial drainage in extra-abdominal cases is seen to have a decided mitigating effect.

TABLE VII.

(January, February and March, 1941—245 cases)

Operation	No pre-operative respiratory infection			Pre-operative respiratory infection present		
	No.	Post-operative complications	%	No.	Post-operative complications	%
Abdominal	22	1	4	19	8	42.0
Extra-abdominal	130	—	—	74	1	1.3
Total	152	1	0.65	93	9	9.7

Finally, the efficiency of post-operative treatment is a factor which may deter or provoke the development of a post-operative pulmonary complication.

Post-operative atelectasis and infection usually do not make their appearance until 24–36 hours after surgical interference and this delayed onset is significant, for the continued retention of pulmonary secretion during this first 24 hours of convalescence favours the development of post-operative atelectasis or pulmonary infection, while its elimination during this period has been seen to be effective as a means of aborting a potential post-operative pulmonary complication.

After extra-abdominal operations, generally speaking, the ability to cough effectively early in convalescence is assured, but after abdominal operations, the vital capacity, and consequently the ability to cough effectively, is diminished.

The most important single factor responsible for this diminution of vital capacity is pain on breathing and the relief of pain in convalescence is perhaps the most important single factor capable of increasing the rapidity with which efficient bronchial drainage returns. It is usually taught that drugs such as morphia and codiene inhibit respiration. The R.A.F. have shown us that a patient in pain can tolerate large doses of morphia and it is important to realize that if the patient is a pink colour, slow shallow breathing is due to a lowered metabolic rate and not to a depressed respiratory centre, for lung ventilation is proportional to the metabolic rate. In chest surgery, where the rapid elimi-

nation of pulmonary secretions early in convalescence is essential to the success of surgical interference, morphia is used freely. Thus, after thoracoplasty, morphia gr. ¼ every 6 hours is used as a routine during the first 48 hours of convalescence, and the use of morphia in amounts which will permit the subject to cough effectively during the first 24 hours at least is a most important adjuvant in post-operative treatment.

Re-educational breathing exercises, the object of which is to increase vital capacity, have proved to be an efficient means of encouraging a timid patient to breath deeper and cough effectively. Combined with CO_2 therapy, these exercises enabled Tattersall to reduce the incidence of post-operative pulmonary complications from 78 to 53 per cent.

Finally, the vital capacity is greatest if the patient is nursed in Fowler's position and he should moreover be given the freedom of his bed and encouraged to use it.

Sulphanilamide compounds have been used in this series in all cases with excessive post-operative bronchial secretion. As a routine gm. 2 are given on recovery from anæsthesia and followed by gm. 1 every 4 hours for the first 48 hours of convalescence. The bacteriostatic effect is obvious and by reducing the volume of pulmonary secretion these drugs minimize the risk of atelectasis. Sulphanilamide therapy, however, cannot be expected to replace sound principles of post-operative treatment, but combined with the early elimination of retained secretions is probably responsible for the low incidence of lung parenchyma infections and the relatively benign nature of respiratory tract infections in this series.

An expectorant mixture containing pot. iod. was used in this series and was thought to be of value, but the use of belladonna is open to question. Geoffrey Marshall depreciates its use, and Brock[6] considers it harmful. Post-operative atropine paralyses the glands of the respiratory epithelium and by so doing abolishes the only possible dilutant of goblet cell mucus. In the presence of infection the use of atropine in convalescence therefore renders viscid secretions even more sticky and tenacious, and it is my view that its post-operative use in young troops is harmful.

Assessment

In assessing the relative responsibility of these various factors, it is clear that the basic factor is the most responsible factor.

Each occasional factor serves to accentuate the set of circumstances created by this basic factor and of these, the prevalence of pre-operative respiratory infection has no parallel in normal civilian practice.

Figure 1 shows graphically the monthly percentage of abdominal operations, pre-operative respiratory infection and post-operative pulmonary complications and can be divided for the purpose of analysis into four periods.

In the first period, October 1939 to March 1940—perhaps the most bitter winter in living memory—the percentage of abdominal operations was high, and the fact that the incidence of post-operative pulmonary complications runs in almost mathematical parallel with the incidence of pre-operative infection indicates that almost every abdominal operation which had a pre-operative respiratory infection developed a post-operative pulmonary complication.

During the second period, April to September, 1940, the first summer, the percentage of post-operative pulmonary complications rose steadily to reach a peak of 25 per cent in July, fell to 2 per cent in August, and bears no relationship to either the basic or the occasional factors under review. The surgical intake during this period, however, includes casualties from Dunkirk and Australian troops from this area concerning whom it has been impossible to obtain statistics. A great many Australian troops suffered from respiratory infection, and if these Dunkirk and Australian figures could be included the graph of pre-operative respiratory infection would show a peak rising sharply during May, June and July and receding during August and September when the Australians had become acclimatized; and it is likely, in view of the high incidence of abdominal operations, that the incidence of post-operative pulmonary complications would show the same rela-

tionship to the incidence of pre-operative infection as seen in the first period.

In the third period, October 1940 to March 1941, the second winter, the relatively low percentage of abdominal operations, and the fact that the incidence of post-operative pulmonary complications follows in rough outline the incidence of abdominal operations, indicates that of the cases with pre-operative respiratory infection—and they were numerous—extra-abdominal operations escaped and many abdominal operations developed a post-operative pulmonary complication.

In the fourth period, April to August, 1941, the second summer, the incidence of post-operative pulmonary complications follows in rough outline the incidence of abdominal operations, for as in the third period, only those abdominal cases with pre-operative respiratory infection developed a post-operative chest complication.

This analysis confirms the primary importance of the basic factor and coupled with Table VII indicates that pre-operative respiratory infection is the dominant occasional factor in this series. Table VII also emphasizes the importance of the early return of efficient bronchial drainage in convalescence for even when pre-operative respiratory infection is present, 11 of 19 abdominal and 73 of 74 extra-abdominal operations escaped a post-operative pulmonary complication.

The influence of slow surgery is seen in Table III. Rough surgery cannot be assessed, and the low incidence of atelectasis and the results of Table IV show that local irritation is not an influential factor in this series.

Finally, when pre-operative respiratory infection is prevalent the choice of anæsthesia becomes a factor of extreme importance. The intensity of the basic factor in spinal anæsthesia favours the development of atelectasis and infection, and Table IV indicates that spinal anæsthesia above the level of the sacral nerve roots, particularly in surgical shock, is not the anæsthetic of choice in war-time military surgery.

Continuous intravenous anæsthesia provides neither the comfortable surgical preparation nor the flexible control

of inhalation anæsthesia, and when Rivett and Quale's[7] gynæcological series in Table IV is compared with King's gynæcological cases in Table II it is seen that post-operative pulmonary complications are not less frequent in intravenous than in inhalation anæsthesia. It is my view that continuous intravenous anæsthesia has little to commend it in war-time military surgery.

Summary

1. Post-operative pulmonary complications must be attributed primarily to the inevitable failure of the defence of the pulmonary system during surgical interference produced by the basic factor.

2. The most responsible occasional factor in this series of troops is pre-operative naso-pharyngeal and minor respiratory infection.

3. The use of inhalation anæsthesia coupled with active post-operative treatment offers the most effective means of controlling the incidence of post-operative pulmonary complications in troops.

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THE FUTURE ORGANIZATION OF ANÆSTHETICS

BY

R. BLAIR GOULD, M.B., Ch.B., D.A.

AT the present time much thought is being expended upon the future of post-war medicine, and opportunity may therefore be taken to consider the place in any future scheme of anæsthetics, which is, after all, one of the most important of the specialties. That some consideration is necessary is sufficiently obvious, for the condition of affairs in both the pre-war voluntary and municipal systems gives rise to grave misgivings. I do not wish here to deal with economic aspects of this problem, nor with the larger sphere of hospital organization. In this paper, attention will be briefly directed to the professional organization of the specialty, within whatever type of hospital system may arise after the war, voluntary or State, paid or honorary.

I do not believe that hitherto anæsthetics in this country has made that contribution to medicine which its importance justifies and demands. This art and science has indeed progressed far in recent years, but to this advancement English anæsthetists, with a few outstanding exceptions, have contributed little. This is perhaps only to be expected in a system where anæsthetists have to divide their energies between the ever increasing demands of voluntary hospital work and private practice.

In these circumstances there is little wonder that research, without which there can be no real progress, is uncoordinated and haphazard, where it is not entirely neglected. This is the more to be deplored since the scientific aspects of anæsthesia provide a fruitful field for investigation, which becomes ever more necessary as the art becomes more complicated.

The administration of the anæsthetic is an important item in treatment, and on its success without serious post-operative effect depends often the success of the surgeon. However, the nature of this association between surgeon and anæsthetist is one which indeed demands some investigation and clarification. For generations the anæsthetist has had to submit to dogmatic interference in his own province, interference which the surgeon would be the first to resent were the situation reversed. The surgeon has often assumed an attitude of dominance in the theatre which accords ill with the status which should devolve upon his anæsthetist partner. This dominance, exercised on psychological, professional, and economic grounds, is greatly to be deprecated, for it often constitutes a bar to progress. I do not believe that the practice of medicine in any of its manifold branches can become honest until it cannot profit a man one iota what opinion he expresses as to the treatment of a patient.

One result of this dominance is to make difficult the application of new techniques. The perfection of a new technique depends upon practice. To keep abreast of the advances in his subject it is necessary from time to time to experiment with new agents and methods, and for this purpose the human subject is finally the only satisfactory experimental animal. When he thus experiments he is unlikely to produce as good results as with techniques with which he is more familiar. The experiments may therefore be deferred until a "junior" is operating, the unfortunate patient being then subjected to the double risk of inexperienced surgery performed under difficult conditions.

The surgeon, moreover, often demands of his anæsthetist nothing more than relaxation; by this is usually meant "complete muscular flaccidity, complete peritoneal flaccidity, minimal respiratory movements, and contracted viscera which fall idly back into the abdomen when the walls are lifted."[1] This state is usually described in the text-books as "overdose." The anæsthetist's responsibility to his patient demands that he should preserve a much wider outlook, as I hope to make clear in this article.

Believing, as we all surely do, that all our endeavours should be directed towards giving the maximum benefit

possible to the maximum number of patients, I wish to submit the following views on

The Functions of the Anæsthetist

1. On the patient's arrival into hospital, the anæsthetist and surgeon should consult together: while the latter will be mainly, but not entirely, concerned with measures necessary for diagnosis, the former will be occupied in assessing the physical state present, and in concerting treatment aimed at achieving the best possible condition for operation.

2. The date of the intended operation should be decided by the surgeon and anæsthetist in consultation, and the latter should no longer be presented with a *fait accompli* in the theatre. He should, in fact, have a larger power of veto than he has appeared willing or able to express hitherto. Likewise he should be in the surgeon's confidence at an early stage in treatment as to the scope of the projected operation.

3. The anæsthetist, and the anæsthetist alone, should be responsible for deciding what anæsthetic procedure should be employed in each particular case. It should be recognized that he is just as much a consultant as the surgeon in his own field, and he must be prepared to act as such in any matter which touches on his specialty. Decisions regarding anæsthesia are in my opinion his, and his alone, to take. (In such matters also as the therapeutic administration of gases, and the practice of diagnostic and therapeutic blocks, he may perhaps also be regarded as an expert, and should possess the knowledge necessary to make him so.)

4. During the operation he should advise the surgeon of the patient's condition, and administer, or supervise the administration of, such anti-shock measures as may be deemed appropriate.

5. In association with the surgeon, he should supervise the post-operative progress of the patient, with a view to the diagnosis, prevention and treatment of post-operative complications.

The implications in this scheme are obvious. In the first place a better standard of qualification may be thought

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desirable, so that the surgeon and anæsthetist may meet on equal terms. No criticism of the Diploma is implied here, and such would be impertinent coming from me. But it has been suggested that the possession of a higher medical qualification should be a *sine qua non*. With the complexity and diversity of the drugs used nowadays in anæsthesia, and the complicated nature of the techniques practised, a thorough understanding of theoretical and experimental pharmacology and physiology, at least of the standard of the primary fellowship, would appear essential.

In the second place the argument here advanced would challenge the view that the work of the anæsthetist begins and ends in the operating room. (The use of this word in substitution for the more spectacular term would be more in accordance with changing views on the work which is done therein.) A proper proportion of time spent between operating room, wards, and experimental laboratory would appear necessary if any real advance is to be made in the specialty. The anæsthetic departments of hospitals should be in close touch with the laboratories, and proper facilities should be given to anæsthetists to utilize them.

Thirdly, I consider that no worthwhile advance can be made unless a proper system of record keeping is observed. Anæsthetic records, which would trace the relevant medical history throughout treatment, should preferably be kept apart from the routine surgeon's notes.

Fourthly, I consider that there is no justification for a division of anæsthetics into major and minor. The anæsthetization of a case for a so-called "minor" operation carries with it the same risk as for a major case. Often the risk is increased, for the patient may be less thoroughly prepared, and the surgeon less experienced. There is as much necessity for expert supervision in this type of case as in any other.

Fifthly, there is no justification for a division of anæsthetists into "technician" and "medically qualified," as for example obtains in radiography. Where such a division has been the custom, as in certain parts of the United States, it is usually due to economic reasons, and is recognized as being against the best interests of the patient and the speci-

alty. Individual judgment of the skilled anæsthetist is as much necessary during the administration of the anæsthetic, as is that of the surgeon during the performance of any "stereotyped" operation. Especially in ill patients, and in most others, the administration of a general anæsthetic requires all the skill and discrimination of an experienced man, and can never become a "routine" procedure. The problems of the correct selection of agent and mode of technical administration require experience guided by knowledge and research, and, as Pask has pointed out,[2] can never be solved merely by an examination of indirect evidence.

The Teaching of Anæsthetics

A few brief notes on this important subject may be appended here.

Teaching should not jeopardize blatantly either the interests of the patient or the surgeon. Moreover, there should be a clear distinction between the elementary requirements of the student who is likely to go into general practice and must know how to give a straightforward anæsthetic, and the man who wishes to become a consulting anæsthetist. In both these cases, however, a proper proportion between theoretical and practical instruction is essential. The administration of an anæsthetic cannot be taught by talking about it; nor can the art and science of anæsthesia be learned just by doing it.

In my opinion teaching should include, even if only in an elementary way, all the manifold factors which are involved, e.g., physiology, pharmacology, medical and surgical considerations, the contrasting viewpoints of surgeon, patient and anæsthetist, pre- and post-operative treatment, nursing and complications, shock and its treatment, anatomy of regional and spinal anæsthesia, the mechanics of anæsthetic machines as they affect physiology, the physics of explosions, and so on.

Finally, I believe that the teaching of anæsthetics should begin and end in the wards, not in the theatre. The anæsthetic clerk should be responsible for the anæsthetic note-taking, which should be separate from the surgeon's notes.

Opportunity should be given for the discussion of interesting cases in the wards, from the anæsthetic point of view.

Discussion

For the better realization of the aims expressed above, I very diffidently put forward the following tentative proposals as a basis for discussion:

There should be a Chair of Anæsthetics at each University, the principal object of the occupant being to direct and co-ordinate research in the many and varied aspects of this subject. Under the Professor there would be: full-time posts in association with surgical units; part-time posts; research scholarships for both whole-time and part-time men.

Some of the proposals stated in this article may be thought too idealistic for the modern world, and some may be thought to conflict with surgical prerogative. I believe, however, that this need not necessarily be so: further, I believe very strongly that a re-orientation is urgently to be desired in future in the attitude of the profession towards their hospitals. Clinicians should no longer be under the necessity, by having to depend on fees earned in private practice, of neglecting their major life's work in the large institutions, or of having to consider these as secondary considerations. The object of such a scheme of organization as that outlined here would be to attract into the specialty men of ability who would be given ample opportunities for research, and to give to anæsthetics that status which its importance in the scheme of treatment justifies and demands, that patients may receive from our efforts the maximum possible benefit.

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ASSOCIATION OF ANÆSTHETISTS, GREAT BRITAIN AND IRELAND

THE Annual General Meeting of the Association was held on Tuesday the 28th October, 1941, at the Royal Society of Medicine, 1 Wimpole Street, W.1, at 2 P.M., Dr. Z. Mennell, President, in the Chair.

The following were elected for the ensuing year:

President: Lt.-Col. Ashley Daly, R.A.M.C.

Secretary: A. D. Marston

Treasurer: Z. Mennell

Vice-President: C. F. Hadfield

The Council:

J. Blomfield	H. W. Webber
H. W. Featherstone	R. J. Minnitt
Frankis Evans	I. W. Magill
J. B. Holroyd	R. R. Macintosh
H. G. Sington	V. E. Vessell
J. Beckett	J. H. T. Challis

THE DIPLOMA IN ANÆSTHETICS

AT the Examination for the Diploma in Anæsthetics, held on the 17th, 18th, and 19th November, 1941, by Lt.-Col. Ashley Daly and Drs. C. Langton Hewer, A. D. Marston, and I. W. Magill, 93 candidates presented themselves, of whom 29 passed.

The following are the names, qualifications and hospitals of the 29 successful candidates:

John Bodkin Adams, M.D., B.Ch. Belfast, Belfast; James Henry Crawford, L.R.C.P., M.R.C.S., St. Mary's; Hugh de Lancey Noel Davis, B.M., B.Ch. Oxon., St. Bart.'s and Royal Hants.; Denys Christian Devitt, L.R.C.P., M.R.C.S., St. Thomas's and Mt. Vernon; Robert Russell Dickson, M.B., B.S. Lond., L.R.C.P., M.R.C.S., St. Bart.'s; John Kennedy Addison Dorman, M.B., B.Ch. Belfast, Prince of Wales, Plymouth, and Royal Berks; Henry Edwards, L.R.C.P., M.R.C.S., Guy's and Gloucester R.I.; Hugh Reginald William Franklin, M.B., B.S. Lond., L.R.C.P., M.R.C.S., Guy's and Selly Oak; Ysobel Marion Garland,* M.B., B.S. Lond., L.R.C.P., M.R.C.S., Royal Free and Leicester R.I.; Edmund Frank Gleadow, L.M.S.S.A., Guy's, West London, and Gravesend; Thomas Cecil Gray, M.B., Ch.B. Liverpool, David Lewis Northern; Peter Stuart Arthur Heyworth, L.R.C.P., M.R.C.S., London and Royal Southern Liverpool; Werner Kupfermann, L.R.C.P. and S. Edin., L.R.F.P. and S. Glas., Edinburgh and Manchester Victoria Jewish; Cledwyn Bebb Lewis, L.R.C.P., M.R.C.S., London; Alexander Mackenzie McKinlay,* L.R.C.P. and S. Edin., L.R.F.P. and S. Glasg., East Fortune and Edinburgh R.I.; James Vincent Mitchell, M.B., B.S. Lond., L.R.C.P., M.R.C.S., Middlesex and Radcliffe; Leslie Gordon Morrison, M.B., Ch.B. Edin., Edinburgh and Cheltenham; George Bennett Oliver, L.R.C.P., M.R.C.S., London and North Middlesex; Joseph Patterson, L.R.C.P., M.R.C.S., Guy's and Royal South Hants; George Quayle, L.R.C.P., M.R.C.S., St. George's and N. Middlesex; George Macgregor Rose, L.R.C.P. and S. Edin., L.R.F.P. and S. Glasgow, Edinburgh and R.A.F.; Enid Beatrice Roulston,* M.B., B.Ch. Belfast, Leeds G.I.; Robert Delmage Scott, M.B., B.Ch. Dublin, Chester R.I. and Birmingham; Robert Patrick Webb Shackleton, L.R.C.P., M.R.C.S., St. George's and Park Prewett;

Abraham Abe Shein, L.R.C.P., M.R.C.S., Guy's; Janet Todd,* M.B., Ch.B. Glasgow, Glasgow and Stobhill; Evelyn Cecil Whitehall-Cooke, B.M., B.Ch. Oxon., L.R.C.P., M.R.C.S., St. Thomas's and Willesden General; Joyce Worthington,* M.B., Ch.B. Manchester, Manchester R.I. and Crumpsall, Manchester; Alexander Macarthur Young, L.R.C.P., M.R.C.S., Westminster and West Middlesex.

* Women candidates.

ABSTRACTS

"*Gangrene following Digital Nerve Block Anæsthesia.*" P. A. KAUFMAN, in *Archives of Surgery*, vol. 42, p. 929.

THE patient was a woman of 43, and it is noticeable that no tourniquet was used. The operation was to cure a whitlow of the left thumb. An injection of 2 c.c. of a 2 per cent novocaine solution containing epinephrine was made into each side of the base of the thumb. Pus was released on incision and bleeding was noted at the time. Later the patient immersed the thumb in a solution of boric acid in boiling water; anæsthesia was apparently still present as she noticed the heat only when the solution reached the palm, when she withdrew the thumb. Next day the thumb was painful and dusky. Three days later she was admitted to hospital with a swollen, gangrenous thumb which smelt foully. The appearance was that of a Welchii infection, but only staphylococci could be grown from the discharge. Within a week there was a line of demarcation obliquely round the base of the thumb. Spontaneous amputation was permitted to occur in the proximal phalanx. The author tabulates 25 other cases. He recommends avoidance of both tourniquet and epinephrine.

"*A New Intravenous Anæsthesia Outfit.*" W. E. GIBSON, M.D., Madison, Wisconsin, in *Anæsthesia and Analgesia*, November-December 1941, p. 353.

THE author describes, with illustrations, apparatus designed to facilitate the administration of intravenous anæsthesia. It consists of the usual outfit for injecting normal saline, a special mixing adapter, an automatic one-way valve, 4 inches rubber tubing, a 20 c.c. glass syringe, and a 20 gauge, 1½-inch short bevel needle. The parts are equipped with the Luerlok feature to ensure easy assembly, and leak-

proof connections. The rubber tubing leading from the saline reservoir is attached to the mixing adapter and needle; the syringe, with automatic valve and 4 inches rubber tubing attached, delivers the anæsthetic solution through the side arm of the mixing adapter to the needle, thus it is injected into the stream of saline and carried into the vein.

The syringe may be clamped into place, and need not be touched except to administer more anæsthetic—this is an advantage over the 3-way stop cock where the needle has to be held in the vein. The automatic valve prevents air getting into the system if the syringe is removed for refill. The author recommends that for long operations 100 per cent oxygen should be given when continuous intravenous anæsthesia is being used.

"Anæsthesia in the Patient with Pulmonary Tuberculosis." H. E. PUGSLEY and G. D. RICHARDSON in *Canadian Med. Assoc. Journal*, May 1941, p. 473.

THE authors state that these patients tolerate anæsthesia and operation well, but a certain small proportion suffer from post-operative spread of the tuberculous disease. This they attribute partly to lowered resistance to tuberculous infection, resulting from surgical shock. To avoid this they recommend pre-operative preparation, multiple-stage operations whenever possible, routine intravenous saline during major surgery, and blood transfusion if shock appears. For minor operations local anæsthetics should be used or pentothal if the former are unsuitable. For major operations below the umbilicus spinal analgesia is chosen, novocaine for short and percaine for long procedures. For major thoracic operations cyclopropane is first choice. As regards pre-operative preparation the first essential is that patients in the acute exudative phase should, if possible, have a long period of rest in bed before operation so that the lesion may become fibrotic. Post-operative spread of the tuberculous process is thus rendered much less likely. During operation reflex breath-holding may occur when

periosteum is chipped off a rib or the parietal pleura from the chest wall. This causes anoxæmia and contributes to development of shock. In order to avoid this complication cyclopropane anæsthesia should be induced at least ten minutes before the operation begins and deepened to the second plane of the third stage. When the surgeon begins to close the muscle layer the anæsthesia is lightened by addition of air or a helium-oxygen mixture.

"*Anoxia in Surgery and Anæsthesia.*" SCHNEDORF, LORHAN and ORR in *Archives of Surgery*, August 1941, p. 169.

THE authors describe two cases in which, from the post-mortem histological investigations of the brain, they believe death to have been certainly due to cerebral anoxia. In one instance the anæsthesia was produced by pentobarbital sodium morphine and scopolamine, followed by spinal injection of percaine hydrochloride, in the other (a child) ether alone was given for one hour. Drawings are given showing the degenerative changes found in the cerebral tissues. The authors state that the barbiturates have been shown to produce various degrees of anoxæmia both experimentally and clinically; nitrous oxide anæsthesia is often associated with anoxia; ether in large quantities produces anoxæmia. Anoxæmia is not a factor in spinal analgesia as long as the blood pressure is maintained. Surgical shock is, of course, associated with anoxia. The authors regard prevention as the best treatment. Adequate pre-operative treatment and blood transfusion play an important part, and oxygen should be used with anæsthetics known to produce anoxæmia. If this occurs the Trendelenburg position and high concentrations of oxygen are to be employed.

"*Adrenal Glands in Shock.*" G. L. BESSEN, in *Archives of Surgery*, vol. 43, p. 249.

THE author discusses the evidence existing to show that the adrenal cortex acts as a protective mechanism against shock. Much experimental work seemed to support this

idea. Consequently he carried out a number of clinical investigations. Desoxycorticosterone acetate, a synthetic product having properties of adrenal cortex, was given to 72 patients undergoing extensive surgical operations. The drug was given before operation. This product was, however, found to be of little significant value in preventing shock, as evidenced by comparison of treated patients with controls.

"*Oxygen in Experimental Shock.*" H. A. DAVIS, in *Archives of Surgery*, vol. 43, p. 1.

THE investigation of the effects of giving oxygen to normal animals and to animals suffering from shock and from shock associated with hæmo-concentration, has led to certain conclusions which may well turn out to be of value to the clinician. Administration of oxygen was shown to be most efficacious when the reduction of the blood volume had ceased, and to be least useful when shock was associated with a continued decrease of the blood volume. The best results were obtained in animals with mild hæmorrhagic shock. Oxygen administration, says the author, should be regarded only as a subsidiary form of treatment in shock. The administration of oxygen is useless if the blood volume continues to decrease. If the volume is low but no further decrease occurs then oxygen may have the effect of stabilizing the blood pressure and preventing its further fall till other forms of therapy are available.

"*Avertin-nitrous-oxide Anæsthesia in Thyroidectomy.*" K. I. HEARD, in *Canadian Med. Assoc. Journal*, September, 1941, p. 209.

THE author gives the results obtained from a consecutive series of 110 patients all operated on by the same surgeon and receiving the anæsthetic from the same anæsthetist. This eliminates data which make judgment of results difficult when various operators and anæsthetists are concerned. Ninety per cent of the patients were kept in anæsthesia by nitrous oxide, with comfort to the anæsthetist and safety to

the patients. Heard uses full doses of avertin for these subjects, all except 6 had 100 mgs. per kilo of body-weight. He gives the avertin at least half an hour before operation and does not approve of any allied premedication. If a stronger anæsthetic is needed he prefers to add cyclopropane rather than ether. This was done in only eight patients. Nor does he prefer to pass an endotracheal catheter as a routine, although he has at every operation a complete set of catheters and laryngoscope at hand. Generally speaking, it is best not to induce that depth of anæsthesia needed for passage of the endotracheal tube. Probably whenever there is an excessively large or retrosternal gland the tube should be used. There was no death in the series, and complications were few.

REVIEW

"*Endotracheal Anæsthesia.*" NOEL A. GILLESPIE, with a foreword by I. W. MAGILL, RALPH WATERS and ARTHUR GUEDEL. pp. 187. University of Wisconsin Press, 1941.

THIS is one of the best books of its kind ever published. It is very well written and gives a detailed account of the history and present-day uses of endotracheal anæsthesia. The high standards of interest and accuracy set in the first chapter are maintained throughout the book, and we feel sure that every reader will appreciate the outstanding qualities of this work.

In dealing with the subject of intubation the author makes use of diagrams, coloured plates and X-rays to illustrate the difficulties frequently encountered by the anæsthetist in both orotracheal and nasotracheal methods. There are several instructive and interesting passages on endotracheal anæsthesia in infants, a subject which, though presenting many difficulties, is only too frequently omitted from text-books. Referring to post-operative respiratory complications the author points out that no reliable evidence has yet been produced to support the view that they occur more frequently in patients that have been intubated, but statistics show that when they do occur after endotracheal anæsthesia the incidence is higher when the oral route has been employed in preference to the nasal.

There are a few omissions to be pointed out for future editions. In describing the advantages of intubation for abdominal surgery the author points out that a stomach tube may be passed if necessary without interrupting the course of the anæsthesia, but does not refer to the fact that, unless a rigid or small endotracheal tube is used, the large stomach tube with its thick walls frequently compresses the endotracheal tube causing obstruction to the respiration;

in our experience a smaller œsophageal tube is more satisfactory. In his description of apparatus and equipment, the author refers to the T-shaped connection used by Ayres for endotracheal anæsthesia in infants, but makes no mention of the flexo-metallic tube designed by Magill for this work. He also stresses the fact that an endotracheal tube should be fixed to the metal connection or patient's cheek with strapping, as there is a danger of the metal connection slipping out of the rubber tube which may then be aspirated into trachea or bronchus. To one who has been in danger of losing a tube in this way it seems safer to tie a piece of silk thread round the junction of metal connection and tube especially in E.N.T. work when the operation is generally performed in darkness. The Goldman ring and harness for keeping endotracheal tubes in position is also not mentioned. This seems a more efficient method than the strapping recommended by the author. Though the uses of cocaine and other local anæsthetic agents as a preliminary step to intubation are described, we think that as this procedure has to be efficiently performed if it is to be of any practical use, the reference is incomplete and too brief.

Otherwise this excellent work is full of useful information, and also contains several interesting accounts of cases. We think the book is indispensable for any anæsthetist who wishes to be fully informed on the subject of endotracheal anæsthesia.

Obituary

H. E. G. Boyle, O.B.E., F.R.C.S., D.A.

MANY memories come surging back at the mention of H. Edmund G. Boyle, and it is with great regret that his passing is recorded. We all knew him as "Cocky" Boyle, which was not a term of familiarity, but of endearment. He has been a familiar figure to many Bart's men throughout the years, and has had no little influence on the lives of a large number of students in his capacity as a teacher of anæsthetics. He was born in Barbados in 1875, and after some years at school there came to this country and commenced studying medicine at St. Bartholomew's. When he qualified he became a resident anæsthetist at Bart's eventually being elected to the visiting staff. He held this appointment until ill-health necessitated his retirement, when he was elected consulting anæsthetist. For his services in the last war he was appointed an officer of the Order of the British Empire, and later was made an Honorary Fellow of the Royal College of Surgeons. He was also one of the first to be awarded the Diploma in Anæsthetics, and was one of the first two examiners for this Diploma.

Boyle's name is particularly associated with the administration of nitrous oxide and oxygen, which he sponsored in this country. He it was who modified Gwathmey's machine and made it into the foremost apparatus for gas-oxygen administration in this country, and it still holds a prominent place in the armamentarium of the modern anæsthetist. Boyle did much for anæsthesia by his pioneer work in nitrous oxide-oxygen anæsthesia, and he brought back with him from America the Sorensen suction pump for use in throat surgery. While in America he met many well-known and interesting anæsthetists, and it was of Boyle that each noted American anæsthetist asked when visiting this country. "Cocky" was very popular among

his American colleagues, and was held in high esteem by all who knew him. His interests were not only confined to apparatus, for he was a prominent member of the Anæsthetic Section of the Royal Society of Medicine, of which he was President in 1923. Also he was a member of the editorial board of the *British Journal of Anæsthesia*, and was an original founding member of the Association of Anæsthetists of Great Britain and Ireland. He wrote well, too, for his book, *Practical Anæsthetics*, was most popular and was widely read.

In other walks of life Boyle was prominent. He was a Mason of long standing, and had risen high in the craft. He was a Past Master of the Rahere Lodge, and still held high office in the Lodge. His interest in Rugby football was very real, and in his young days as a student he played himself. As a host he will be remembered for his gaiety and kindliness, and his death has deprived his colleagues of an old friend. I personally owe him much, for he taught me the mysteries of anæsthesia, and I am very sorry indeed that he has gone from us so soon.

F.T.E.

CORRESPONDENCE

To the Editor, *British Journal of Anæsthesia*.

AMERICAN HOSPITAL IN GREAT BRITAIN,
PARK PREWETT,
BASINGSTOKE.

SIR—It gave me great pleasure to see in the correspondence section of your last issue that Dr. Langton Hewer had interested himself in my contention that the administration of sulphapyridine presents no contra-indication to the employment of pentothal sodium in anæsthesia. Practical experience based upon many hundreds of service and civilian casualties has put the matter beyond doubt in my mind. I append below the tables (condensed) compiled by myself, which were published by R. Smith in the *British Medical Journal* (October 12th, 1940), of the original short series of cases to whom I personally administered the anæsthetics, and which first convinced me.

Cases receiving "M & B" intravenously at operation

Case 1.	"M & B"	grams	1	pentothal	grams	1.75
,, 2.	,,	,,	1	,,	,,	0.3
,, 3.	,,	,,	1	,,	,,	0.5
,, 4.	,,	,,	1	,,	,,	0.5
,, 5.	,,	,,	1	,,	,,	0.5
,, 6.	,,	,,	1	,,	,,	0.5
,, 7.	,,	,,	1	,,	,,	0.5

Cases receiving "M & B" intravenously within 24 hours of operation

Case 8.	"M & B"	grams	1	pentothal	grams	0.5
,, 9.	,,	,,	1	,,	,,	0.5

NOTE TO THE SUBSCRIBERS AND ADVERTISERS

THE last issue of the Journal, Vol. XVIII, No. 1, is the January Number. It was by a printer's error labelled "March, 1942." For the sake of uniformity the two numbers which we issue annually in wartime are the January and July numbers for the year, whatever the month in which they appear.